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INSTITUTE OF FOOD AND AGRICULTURAL SCIENCES
Center for Aquatic Weeds

AQUAPHYTE

FLORIDA DEPARTMENT OF NATURAL RESOURCES
U.S. ARMY CORPS OF ENGINEERS, WATERWAYS EXPERIMENT STATION
AQUATIC WEED PROGRAM

Volume 6, Number 1 GAINESVILLE, FLORIDA Summer, 1986

INFORMATION EXCHANGE HALTED - INTERNATIONAL SPONSOR SOUGHT

This is the final issue of AQUAPHYTE and the end of Aquatic Plant Information and Retrieval Services for some 2,000 international subscribers unless a sponsor is located to fund the international portion of the Aquatic Weed Program. This issue is being mailed to users in 65 countries to let them know that the program can no longer offer its services outside the United States.

After 8 years, the contract with the United States Agency for International Development (USAID) expired in May 1985. Negotiations with AID continued through October 1985, at which time the agency decided it no longer could financially support the services. Thus, for several months we have had no international funding to support services for overseas subscribers to the Aquatic Plant Information Service.

Of the regular users of these services, one third are in the state of Florida, one third are elsewhere in the United States, and one third are foreign users. Funding continues to provide for domestic services in the U.S.; however, we can no longer bear the $30,000 annual cost of providing services to foreign scientists, water resources managers, teachers and government personnel in 65 countries.

The University of Florida's Aquatic Plant Information and Retrieval System has been invaluable to numerous overseas scientists where libraries cannot afford to subscribe to the many journals which contain research results on aquatic plants. It is the world's largest holding of books, reports and research articles on the subject of aquatic plant biology, ecology, utilization and management. More than 23,000 references are cataloged in a computerized database according to subject areas and keywords. Articles often are provided on a complimentary basis.

The library service was begun in 1976 as worldwide concern and research on aquatic plants began to increase dramatically. International use of the system has increased annually since the service was begun. Currently, nearly 500 foreign users receive regular computer updates (new citations) in the subject areas of their interest. In addition, approximately 1,400 copies of articles, reports and so on have been provided annually to foreign users of the service. The newsletter AQUAPHYTE was begun in 1983 and has been sent free-of-charge to 4,000 subscribers throughout the world as the only regularly published newsletter regarding aquatic plant meetings, new books, conferences and research news. Approximately 2,000 newsletters are sent to foreign subscribers.

We have enjoyed providing assistance to our foreign friends and will continue to do so if and when we can locate a sponsor to provide funds to offset the high costs of producing and mailing information overseas.

Domestic U.S. service will continue through support from the Center for Aquatic Weeds, the Florida Department of Natural Resources and the Aquatic Plant Control Research Program of the U.S. Army Corps of Engineers Waterways Experiment Station.

For a detailed proposal or more information, contact the Aquatic Weed Program, 2183 McCarty Hall, University of Florida, Gainesville, Florida 32611. (904) 392-1799.

Nearly 150 people attended the four-day Aquatic Weed Short Course at the University of Florida in June. During an afternoon field trip to nearby Orange Lake, participants boarded boats to observe the effects of different herbicides on plots of dense hydrilla. See story on page 5.

ECONOMIC LOSS RESULTS FROM HYDRILLA INFESTATION

Recently, researchers at the University of Florida Center for Aquatic Weeds and the Department of Fisheries and Aquaculture have completed several years of research on the impact of hydrilla on the fishing and the local economy of an infested lake in northern Florida.

Orange Lake is a 13,350 acre lake with a national reputation for its largemouth bass, bluegill, redear (shellcracker) and crappie (speckled perch) fishing. Historically, the lake once had a wide fringe of plants such as spatterdock, maidencane, coontail, southern naiad and bladderwort. However, the public usually enjoyed 6,700 acres of vegetation-free open water.

In 1974, one acre of hydrilla (*Hydrilla verticillata*) was first recorded in the lake. Within three years, only 282 acres of Orange Lake remained free of vegetation in the productive lake, the balance being covered with dense mats of hydrilla. Irritated fishermen were unable to move their boats through the mats or to fish through the interfering tangle of stems and leaves.

As a result, fishermen gave up their efforts on the lake and went elsewhere. Research shows that in 1977, 90% fewer fishermen used Orange Lake than in 1974, resulting in a significant loss to the local economy. In 1974, fishing expenditures on Orange Lake were calculated to be $1.02 million. By 1977 fishing expenditures had fallen to $112 thousand.

Fishermen reported that they ceased fishing Orange Lake because hydrilla had decimated the fish populations. In fact, fishermen who devised new fishing techniques and continued to fish the lake actually caught fish at an equal or slightly greater rate than they did when there was no hydrilla problem. The studies determined that the numbers of harvestable bass and crappie were not negatively affected by the abundance of hydrilla. (On the other hand, numbers of harvestable bluegill and redear steadily declined as hydrilla levels increased.) In the peak hydrilla year of 1977, the largemouth bass hourly catch rate was higher than in previous years, and in 1982, black crappie fishing success was much greater than in previous years. The studies also showed that the total fish harvest and fishermen success rates were the same during 1974 and 1982, even though hydrilla covered less than 1% in 1974 and 67% in 1982.

Limited aquatic weed control in recent years has kept hydrilla coverage on Orange Lake to less than 70%. Lake access areas and fishing trails through the hydrilla are periodically treated. The studies show that aquatic weed control and the willingness of fishermen to learn new fishing techniques has enabled fishing expenditures to rebound; in 1982 they were nearly $2 million. If aquatic plant control ceases, hydrilla will quickly return to or exceed the 1977 levels when 91% of the lake was covered.

(Continued on page 7)

EUROPEAN GROUP ON MICROPHYTES AND MACROPHYTES

The European Group on Microphytes and Macrophytes was formed in 1977. The Group's purpose is to establish open scientific cooperation for research on the utilization of aquatic plants. The Group investigates the use of aquatic plants in water purification systems; improves the functioning of these systems by studying the characteristics of microphytes, macrophytes and other system components; and studies the roles of aquatic plants in their environments.

The Group's principal objective is to provide for the exchange of information among its members. It attempts to connect the knowledge of fundamental plant biology and ecology to the processes of designing, installing and managing water treatment systems by bringing together researchers from these scientific realms. Nearly 100 people from France, Italy, Switzerland and Belgium have met over the years to join their knowlege of the biology and ecology of aquatic plants and their use in water treatment systems.

Regional officers of the group are: G. Blake, Chambery, France; V. Bombelli, Milan, Italy; C. Drakides, Montpellier, France; A. Dutartre, Cestas, France; J.M. Hubac, Orsay, France; J.B. Lachavanne, Geneva, Switzerland; M. Radoux, Arlon, Belgium; and M. Vuillot, Lyon, France. For more information, contact Dr. G. Blake, Universite de Savoie, Department de Biologie-Ecologie—B.P. 1104, 73011 Chambery Cedex, FRANCE.

PUBLIC MEETINGS ON WEED CONTROL HELD

At the request of the Citrus County (Florida) Commission, the Center for Aquatic Weeds recently participated in five public meetings which were held to discuss the county's aquatic plant management program. Several hundred residents attended the meetings, seeking information on plant management goals and techniques. The meetings were organized by Dr. Joe Joyce, director of the Center for Aquatic Weeds and Mr. Tom Dick, manager of aquatic plant control in Citrus County. The Center's limnologist, Dr. Dan Canfield, also participated.

Citrus County, with its many water resources, has the third largest aquatic plant management program in the state. The easternmost part of the county is dominated by the plant-filled Tsala-Apopka chain of lakes. Much residential development has taken place on these lakes. The westernmost part of the county borders the Gulf of Mexico and includes King's Bay, a major winter home for the endangered West Indian manatee. King's Bay is surrounded by development and also is infested with aquatic plants. Several rivers also traverse the county and require aquatic plant control. The county uses chemical and mechanical methods for control of hydrilla, waterhyacinth and other nuisance plants.

Homeowners on these water bodies, as well as other county water users, have raised questions about aquatic plant management. Some have asked for more plant management, some have asked for less. Some are fearful of herbicide use in waterways, some fear that aquatic plant management adversely affects manatees. All wish that plant management would cost less than it does.

The public meetings were held to discuss these issues. Dr. Joyce presented the state-of-the-art of aquatic plant management and addressed residents' concerns about herbicide toxicity, herbicide effects on non-target organisms, and relative economic and environmental costs of biological, chemical and mechanical controls. Dr. Canfield, an expert on the trophic states of Florida's waters, explained nutrient loads, productivity and eutrophication processes. Mr. Dick discussed his department's work scheduling and expenditures.

Mr. Tom Dick answers questions of Citrus County homeowners.

THE ARMY CORPS OF ENGINEERS AND AQUATIC PLANTS

(The following is from a Public Information Fact Sheet produced by the Jacksonville District U.S. Army Corps of Engineers)

Aquatic plant control operations be the Corps of Engineers in Florida began in the 1890's soon after the water hyacinth was introduced into the state near Palatka. In 1897, upon petition of the concerned citizens of Palatka seeking relief from the navigation problems caused by the water hyacinth, the Corps undertook an investigation of the plant on the river. This investigation resulted in the initial authorization for the maintenance project by the River and Harbor Act of 3 March 1899. An expanded pilot project was authorized by Public Law 85-500 passed by the 85th Congress on 3 July 1958. This project was later amended on 27 October 1965 by Public Law 89-298 to a continuing "program" approach.

OPERATIONS

Today, aquatic plant control operations by the Corps of Engineers in Florida are performed under two separate authorizations. One, the Removal of Aquatic Growth Project (RAGP), is the original operation and maintenance project for the protection of navigation on federal project waters and the other, the Aquatic Plant Control Program (APCP), is a cooperative program of the control of water hyacinth and other obnoxious aquatic plants in all navigable waters.

The RAGP is 100 percent federally funded. The Aquatic Plant Control Program is a cost-sharing program of 70 percent federal and 30 percent state of Florida funds, except that research and planning costs are 100 percent

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AQUAPHYTE is the newsletter of the Center for Aquatic Weeds and the Aquatic Plant Information and Retrieval System of the University of Florida Institute of Food and Agricultural Sciences (IFAS). Support for the Information System is provided by the Florida Department of Natural Resources and by the U.S. Army Corps of Engineers Waterways Experiment Station Aquatic Plant Control Research Program (APCRP).

EDITOR: Victor Ramey

AQUAPHYTE's circulation is 4,000. It is distributed to aquatic biologists and agencies in 65 countries. Comments, announcements, news items and other information relevant to aquatic plant research are solicited.

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CONGRESSIONAL HEARING ON AQUACULTURE

Part of Washington, D.C. moved south to Gainesville, Florida recently when a congressional hearing was convened to hear testimony about the promises and problems of warm water aquaculture. U.S. Congressman Don Fuqua chaired the hearing of the Committee on Science and Technology of the U.S. House of Representatives, which took place at the University of Florida on April 28, 1986.

Congressman Fuqua said the hearing was held because several problems which face the U.S. and other countries can be ameliorated by a strong committment to aquaculture. He particularly noted that the U.S. trade deficit is increasing, Americans are eating more seafood, and fish yields from natural resources are declining. Therefore, he said, aquaculture offers unique opportunities to supply new sources of food. During the Congressional hearing, two panels of aquaculture specialists discussed the needs and opportunities of aquaculture and the national and state policies which deter or augment commercial aquaculture.

In 1980 the U.S. Congress passed the National Aquaculture Act; it later placed responsibility for aquaculture research and production with the U.S. Department of Agriculture. In 1984 at the University of Florida Institute of Food and Agricultural Sciences, the Department of Fisheries and Aquaculture was established. Its chairman is Dr. Jerome V. Shireman.

Congressman Fuqua said that Congress has authorized the construction of four regional aquaculture centers in the United States. Because of Florida's existing aquaculture industry and its potential for expansion, he believes one of the research centers should be built at the University of Florida. At a press conference, Fuqua said that such a center would "compliment the U.F. Department of Fisheries and Aquaculture, the U.F. Center for Aquatic Weeds and the U.S. National Fisheries Laboratory" in Gainesville.

Welcoming the hearing to campus, U.F. President Marshall Criser said that the University of Florida is ready to assume a greater role in aquaculture research and extension. He was seconded by Vice-President of Agricultural Affairs Dr. Kenneth Tefertiller who said "Florida has the right technology and is the right place for aquaculture." The Secretary of the Florida Department of Agriculture, Doyle Connor, testified that aquaculture "should be an integral part of agriculture in Florida" and that his department already has set up a laboratory to diagnose diseases in aquacultural facilities.

Transcripts of the testimony given at the April 28 hearing can be found in the U.S. Congressional Record.

NOTICE

The Aquatic Weed Program continues to provide information services to users in the United States.

However, because of the lack of an international sponsor, the program is unable to provide these services to users outside the United States. We are pursuing international support and welcome any suggestions as to how to fund services for clients in other countries. The program is not able to bill or receive payments on a "per use" basis. (See INTERNATIONAL SPONSOR NEEDED for more information.)

U.S. Congressman Donald Fuqua meets the press before Congressional hearing.

NEW FISHERIES AND AQUACULTURE DEPARTMENT

Florida's abundant water resources and subtropical climate have given rise to fluorishing and valuable fisheries and aquaculture industries. In 1984, the Department of Fisheries and Aquaculture was established to meet the research and educational needs of these industries. Dr. Jerome V. Shireman was selected to be chairman of the new department which is part of the School of Forest Resources and Conservation (SFRC) in the Institute of Food and Agricultural Sciences (IFAS) at the University of Florida in Gainesville.

There are three areas of primary emphasis in the department. The freshwater fish and limnology program studies physical, chemical and biological factors which influence fish production in Florida waters. Particular emphasis is placed on sportfish production and the influence of aquatic weeds and eutrophication on fresh waters.

The marine and coastal fisheries component studies the needs of breeding stocks and reef communities as well as finfish and crustacean fisheries.

The aquaculture program studies the conditions necessary for maximum commercial production of freshwater, estuarine and marine organisms in the aquarium fish and food production industries.

The new department works closely with the IFAS Center for Aquatic Weeds and the National Fisheries Research Laboratory. It also works with the Florida Sea Grant College and the U.S. Cooperative Fish and Wildlife Unit as well as several other federal and state agencies.

The address is: Dr. Jerome V. Shireman, Chairman, Department of Fisheries and Aquaculture, IFAS, University of Florida, 7922 N.W. 71st Street, Gainesville, Florida 32607 USA; (904) 376-0732.

SALVINIA IN SRI LANKA

What "a fleet of 50 large-size mechanical weed harvesters" cannot do may be done by millions of tiny weevils if all goes well in Sri Lanka.

In March 1985, *Salvinia molesta* covered 40 hectares of the Maduru Oya Reservoir in Sri Lanka. Only two months later, the pest plant covered 3,157 hectares (an estimated 316,000 tons of plant material), an 80-fold increase. Half the reservoir was covered and the plant threatened to spread to downstream paddylands and other parts of the massive Mahaweli Development Project. Salvinia also has established in Polgolla Barrage and NDK Dam. Authorities believe that mechanical control methods would be inadequate and so have decided to import a tiny weevil, *Cyrtobagous*, known elsewhere to be an effective biological control agent of the noxious floating fern.

According to reports of the Mahaweli Authority's Headworks Administration Operations and Maintenance Division (HAOM), mechanical and chemical methods were tested against the fast-growing plant without appreciable effects. "Even a fleet of 50 large-size mechanical weed harvesters would probably not have been able to control the spread," said one report. As for chemical control, the HAOM tested a 10% ammonium hydroxide solution which caused the plants to "die off in irregular patches". Shading the plants with black plastic was determined to be impractical on such a large scale. In the meantime, permits were obtained to import *Cyrtobagous*, and Dr. Peter Room of Australia agreed to deliver a batch of the insects for quarantine, breeding and testing in Sri Lanka.

Cyrtobagous has been introduced into Australia to control salvinia in large reservoirs. In each case, severe infestations of salvinia were brought under control within months. It is hoped

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SONAR REGISTERED

Sonar (fluridone) is the most recent aquatic herbicide to pass the U.S. Environmental Protection Agency's (EPA) newer, more stringent, pesticide registration requirements. The product, effective against hydrilla and other aquatic weeds, received full registration by the EPA in March 1986. Fluridone-treated water has no use-restrictions; swimming, fishing and drinking are permissable immediately after herbicide application.

Since 1983, the EPA has required more extensive studies of new pesticides before allowing them to be registered and marketed. The studies include mammalian acute toxicity, subchronic, chronic and carcinogenicity, effects on reproduction and possible mutations and genetic damage, and environmental fate. Sonar was discovered in 1975 by Eli Lilly and Company and for ten years has been researched in the laboratory and in the field.

Fluridone is a slow-acting herbicide which works by inhibiting the plant's ability to synthesize carotenoids (yellow pigments). Carotenoids protect the plant's green pigment (chlorophyll) from photolysis (breakdown by sunlight). Without carotenoids, chlorophyll is destroyed and the plant cannot photosynthesize. Terminal buds of the plant begin to turn white and the plant dies in 30-90 days, which tends to minimize the possibility of dissolved oxygen depletion and fish kills.

The primary process for fluridone degradation in water is through photolysis. The half-life of fluridone ranges from five to 60 days with an average of 20 days, depending on environmental factors. The potable water tolerance established by the EPA is 0.15 mg/L.

Many submersed, emersed, floating and ditchbank plants are susceptible to the herbicide. Weed control periods of more than one year from one application have been reported.

Sonar is available in three formulations: aqueous suspension (AS), granules (5P), and slow-release pellets (SRP). The liquid and granule formulations are for use in areas with restricted water flow. The pellet formulation is for use in areas where water flow cannot be restricted, such as in canals with slow-moving water.

For more information, contact Elanco Products Company, Lilly Corporate Center, Indianapolis, Indiana 46285. (317) 261-5589.

REPORT ON A NEW INVASION BY *MIMOSA PIGRA* IN AN AFRICAN NATIONAL PARK

by Dr. S.R. Thompson, Geography Department, University of Zambia, P.O. Box 32379, Lusaka, ZAMBIA.

Mimosa pigra is generally not considered to be a serious noxious weed in Africa as it is elsewhere in the tropics. On the contrary, it has been observed in West Africa that *M. pigra* is beneficial to large browsing mammals such as hartebeest and elephant because it is one of the few species to remain green and palatable during the long dry season (Geerling 1973). In Lochinvar National Park in Zambia, however, *M. pigra is spreading and shows signs of becoming a weed which might require control.*

Lochinvar National Park, located on the broad floodplain of the Kafue River, is one of Central Africa's finest habitats for water birds and is the only locality of the Kafue lechwe antelope (Kopus leche kafuensis). Although *M. pigra* is present in similar habitats in other parks in Zambia (eg. Kafue National Park), the populations are small, restricted to river banks, and usually heavily browsed by elephants, eland and other animals. These browsers may help spread the plant. In Lochinvar National Park, however, most large mammals are grazers and to our knowledge do not eat the shrub.

During the long dry season from April to November, the lechwe depend on the dense aquatic vegetation which grows in the flooded zone, while zebra, wildebeest and other antelope feed on drying grass and herbs. Unfortunately, *M. pigra* is encroaching on the favoured feeding grounds of the lechwe and on nesting sites of aquatic birds, i.e. along the banks of the Nampongwe River, into its delta, and on the Kafue River floodplain proper. We are concerned that *M. pigra* will eventually reduce access to the flooded zone by forming dense thickets along its margins, and will decrease the cover of grasses in other areas of the park which are heavily grazed during the wet season.

Prior to about 1980, there was one large population of *Mimosa pigra*, occupying approximately two hectares, at the head of the Nampongwe River, although it had previously been recorded on river levees bordering the Kafue River (Douthwaite and Van Larien 1974). Aerial and ground surveys undertaken from 1983 to 1985 indicate that *M. pigra* has since spread downstream and onto the floodplain. It currently infests an area of approximately 100 hectares. The infestation stretches more or less continuously for three kilometers along both banks of the Nampongwe River, and for another 2-3 kilometers along the edge of Chunga Lake. The current episode of range expansion may date from 1979 when water levels during the wet season were unusually high. The local electricity company ZESCO, carrying out trial regulation of water levels in the Itezhitechi Dam, emptied the reservoir during the wet season. *Mimosa* seeds, which are readily dispersed by water, were probably carried much greater distances from the parent population than usual and deposited in wetter sites more favorable for seedling establishment. Because seed pods split into many segments covered by stiff hairs which can become attached to the coats of animals as they pass by, frequent movement of large herds of lechwe from infested sites to the floodplain may further promote seed dispersal.

This season field studies have been set up which will monitor the rate of spread of *M. pigra* into new sites, and provide information on the potential limits of its local range within the park. The focus of the study is on the seedling survivorship of *M. pigra*, and the phenology of the species in relation to seasonal environmental events. Population expansion in five permanent plots (30m X 120m) where shrub densities were initially relatively low is being monitored regularly. Information is being collected on pod and seed production per plant and germination trials are being conducted on fresh and stored seed. We also are monitoring rainfall and seasonal fluctuations in ground water levels and soil moisture along transects from open water to beyond the current zone of occupation by *M. pigra*.

This phase of the study will continue for at least two years. If the spread of *Mimosa* continues, the study will investigate methods of control or elimination of this weed from Lochinvar N.P. and the Kafue Flats.

References:

Douthwaite and Van Larien. 1974. A description of the vegetation of Lochinvar National Park, Zambia. Nat. Coun. Sci. Res. Tech. Rept. (Lusaka) 34: 66 pages.

Geerling,C. 1973. The vegetation of the Yankani Game Reserve: its utilization and condition. Department of Forestry Bulletin No. 3, University of Ibadan, Ibadan, Nigeria.

RELATIVE TOXICITY OF CHEMICAL SUBSTANCES

		Acute Oral - Rats LDC/50 - mg/kg
Fluridone	less toxic	10,000
Glyphosate		5,600
Table Salt		3,000
Aspirin		1,000
2,4-D (DMA)		300-1,000
Copper Sulfate		300
Diquat		230
Endothall		206
Caffeine		192
Nicotine		53
Sodium Cyanide	more ↓ toxic	6.4

NEW ZEALAND SCIENCE

The government of New Zealand publishes a number of scientific journals, including the New Zealand Journals of Agricultural Research, Botany, Experimental Agriculture, Geology and Geophysics, Marine and Freshwater Research, Science, and Zoology. They are published by the Department of Scientific and Industrial Research (DSIR). DSIR also produces a free list of its publications. Write: The Publications Officer, Science Information Publishing Centre, Department of Scientific and Industrial Research, Science Information Division, P.O. Box 9741, Wellington, NEW ZEALAND.

AZOLLA NEWSLETTER

The **Azolla Newsletter** is a new publication for workers interested in *Azolla*, its symbiotic blue-green alga, and biological nitrogen fixation. It was originated at the *International Workshop on Azolla Use* held at Fushou, People's Republic of China, 31 March to 5 April 1985.

The newsletter is intended to help workers share information, to keep abreast of developments in the field, and to maintain current information on *Azolla* specimen collections throughout the world. It includes abstracts of *Azolla* publications, articles on current issues in *Azolla* research and use, reports and recommendations of *Azolla* meetings, news of plant collections and specimen accession announcements.

The newsletter is published in December and June. Subscriptions are free. To subscribe, write to the editor: Dr. Iwao Watanabe, Soil Microbiology Department, International Rice Research Institute, P.O. Box 933, Manila, PHILIPPINES.

U.F. AQUATIC WEED SHORT COURSE

Government and private aquatic plant management personnel met for the bi-annual University of Florida Aquatic Weed Short Course in June 1986. The course was sponsored by the Center for Aquatic Weeds, the Florida Cooperative Extension Service, and the Department of Agronomy of the Institute of Food and Agricultural Sciences. Nearly 150 applicators, technicians and managers attended the four-day course in Gainesville.

The 1986 Aquatic Weed Short Course was an intensive series of lectures, discussions and demonstrations about aquatic ecosystem management. Researchers, university professors, and government regulators explained the problems and current solutions of aquatic plant management in relation to limnology, especially as plant management relates to eutrophication and fisheries. The latest research findings regarding biological control of plants using pathogens, insects and fish also were discussed. And because chemical controls of plants remains the most widely used method, heavy emphasis was placed on them. Herbicide safety, toxicology, permitting, application, calibration and herbicide effects on non-target biota were explained.

HERBICIDE DRIFT

Herbicide drift control is one of the most important problems of chemical control technology. Drifting herbicides sometimes migrate to non-target areas, resulting in damaged crops and ornamentals and justifiably raising the ire of affected farmers, nurserymen and homeowners. Among the presentations of the Aquatic Weed Short Course was one by Dr. Richard H. Wilson, field scientist for the Velsicol Chemical Corporation, who explained the characteristics of herbicide drift and ways to control it.

The amount of herbicide drift produced is directly related to droplet size. Droplets of less than 100 microns in size are most likely to remain airborne and to drift. And droplets of 20 microns or less may remain suspended in the air indefinately. (For comparsion, a typewriter period is 800 microns in diameter.)

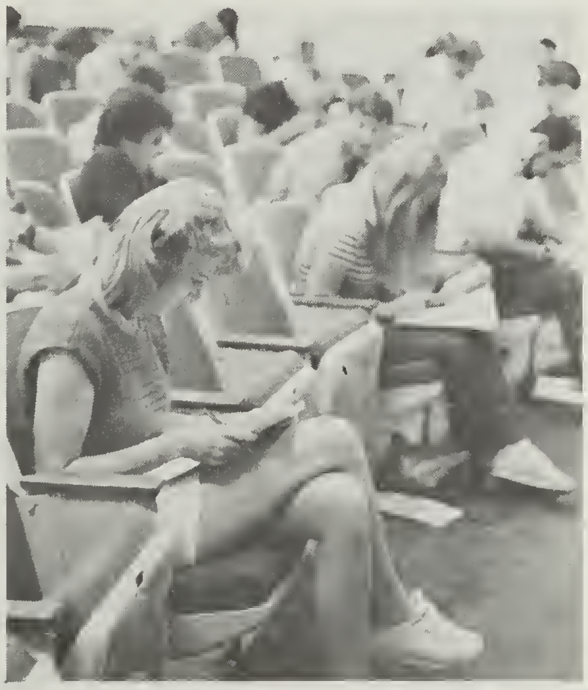
Herbicide drift is influenced by the equipment and application techniques used, weather conditions, and herbicide formulation. Equipment and application account for 68-90% of the drift produced. Though some nozzles are designed to produce larger droplets (and to reduce drift), all nozzles still produce some droplets of less than 100 microns. For example, 3% of the droplets produced by the flat-fan type nozzle are "drift size" droplets. If only 3% of a herbicide drifts onto crop plants, significant damage can result. Another device, the "microfoil boom", is used for aerial application of pesticides from helicopters. The microfoil boom is one of the best application devices because it produces droplets of uniform size, 800 microns in diameter. Droplets of this size are most likely to fall where they are aimed. Another factor to consider in drift reduction is pressure. Higher pressure usually produces smaller droplets, increasing drift. In one study using a flat fan nozzle, increasing the pressure from 20 psi to 40 psi more than doubled the volume of 100-micron or smaller particles. And, of course, spray height also affects drift: the higher herbicide is sprayed, the more likely that winds will capture the drift and carry it off target.

Weather also affects the amount of drift lost from the target area. Wind speed and direction, relative humidity and air temperature, and "inversions" all affect herbicide placement. The most important of these factors obviously is wind speed and direction. On days when strong winds are blowing toward sensitive non-target areas, it would be wise not to apply herbicides. When this truism is ignored, drift damage can occur. Low relative humidity and high temperature will cause the water present in herbicide mixtures to evaporate more readily as drops fall, thus reducing the size of the droplets and increasing drift. Application in 80% humidity will produce less drift than application in 20% humidity. Another weather phenomenon can affect drift. Air inversions (cooler air above holds down rising warmer air) can significantly increase the distance that herbicide drift can travel. This is because the rising cloud of drift (invisible though it may be) is not able to disperse, and so can travel intact until a falling air mass forces the cloud to the ground. Herbicide drift clouds can travel many miles in an inversion before the concentrated cloud falls on someone's tomato crop downwind.

Some herbicide formulations are less likely to produce drift than others. Polymer materials are added to some herbicides to force bigger size droplets. Inverting herbicides (herbicide droplets are surrounded by oil) creates a mayonnaise consistency which cannot drift in the air.

The volatility of a herbicide also determines how much of it will go into the air, and possibly drift off site. (Volatility is the degree to which the herbicide "sublimates" (evaporates).) Volatility is referred to as "secondary drift"; it occurs after the application has been made. Wilson says that volatility is enhanced by temperature and suggests that, when possible, herbicide applications be made in the evening, when the temperature is going down. In aquatics work, this is usually not practical, but at times may be an alternative.

Wilson has authored a 14-page paper on the control and prevention of pesticide drift. He may be contacted at his office: Dr. Richard H. Wilson, Field Scientist, Velsicol Chemical Corporation, 5802 N.W. 57th Way, Gainesville, Florida 32601.



Question: During what part of the day does the lowest dissolved oxygen concentration in a lake usually occur? After four days of lectures, short course participants take the course examination.

USDA/SEA/AR COOPERATIVE AGREEMENT WITH CENTER FOR AQUATIC WEEDS

For eight years, the Science and Education Administration of the U.S. Department of Agriculture has cooperated with the University of Florida Center for Aquatic Weeds by sponsoring "multifaceted research on integrated management systems for aquatic plants in various water systems."

The Cooperative Agreement specifies that the Center will conduct research to determine the most effective integrated systems using biological, chemical and mechanical methods to control undesirable species and to enhance the establishment or re-establishment of desirable species.

Recently completed research includes:

* The evaluation of spawning techniques for efficient production of sterile triploid grass carp which can be used for aquatic weed control in agricultural canals.
* The evaluation of the presence and biology of aquatic nematodes associated with aquatic plants.
* The evaluation of the impact of herbicides used for waterhyacinth control on bulrush communities.

Continuing research under the Cooperative Agreement includes:

* The evaluation of the ability to manage a given quantity and type of aquatic vegetation with the triploid grass carp. The evaluation of the potential of herbivorous fishes for filamentous algae control and efficacy on several hard-to-control species.
* The investigation of the potential control of a filamentous algae, *Lyngbya* with indigenous blue-green algal viruses in order to develop a non-herbicidal control method.
* Plant competition studies and re-establishment of native plant species. The evaluation of the potential of spikerushes and other native plants to reduce the growth of hydrilla.
* The evaluation of the impact, toxicity and methods of integrating chemical waterhyacinth control with the use of the biological control, *Neochetina*.
* The evaluation of the economic impact of aquatic weed infestations on a Florida lake ecosystem and the determination of the potential cost/benefit ratio for the control of hydrilla in a fish management area.
* The evaluation of the physiology and biology of nuisance plants in order to determine the mode of action of aquatic herbicides and methods for increasing herbicidal efficacy.
* The evaluation of herbicides, herbicide combinations, growth regulators, surfactants, timing of application and other parameters to improve herbicidal weed control. The evaluation of the effect of aquatic herbicides and growth regulators on aquatic fauna.
* The evaluation of the physiology of nuisance filamentous algae.

For information, contact:
Director, Center for Aquatic Weeds
Institute of Food and Agricultural Sciences
University of Florida
7922 N.W. 71st Street
Gainesville, Florida 32606 USA
(904) 376-0732

AQUATIC WEEDS IN PORTUGAL

by I. Moreira and T. Ferreira, Departamento Botanica, Instituto Superior Agronomia, P-1399 Lisboa Codex, PORTUGAL.

A fair number of aquatic macrophytes have been reported as weeds in Portuguese freshwater ecosystems. Emergents like *Phragmites australis, Typha domingensis,* and *T. latifolia* frequently obstruct drainage channels and damage irrigation schemes. Dense growths of floating and submersed plants such as *Potamogeton pectinatus, P. crispus, Ceratophyllum demersum, Zannichellia palustris, Lemna spp.* and *Azolla caroliniana,* prevent circulation patterns, increase evapotranspiration and disturb aquatic trophic chains. However, in Portugal the most important aquatic weeds are undoubtedly the waterhyacinth (*Eichhornia crassipes*) and parrotfeather (*Myriophyllum aquaticum*), commonly associated with naturally or culturally eutrophic waters.

Waterhyacinth was first noticed in 1939 in Tagus basin. By 1976, a huge infestation covered the entire surface of Belver reservoir, in mid-Tagus river, and subsequently spread downstream. Parrotfeather has a somewhat more northern distribution and also was first reported in the late thirties in the Vouga and Mondego river basins. Both plants now occur in several main river lowlands (2), especially in small tributaries and irrigation channels.

The Tagus and Sorraia rivers, near Lisbon, enclose a fertile alluvial plain, the so-called Leziria Grande de Vila Franca de Xira. The plain is crossed by a wide net of channels used simultaneously for irrigation and drainage. A fifth of the 570 km of channels, wider than 2 meters, is heavily covered by waterhyacinth or parrotfeather. Since 1977, several experimental studies have been carried out to assess the best strategy for weed control. The studies were led by the Botany Department of the Agronomy Institute of Lisbon, with some equipment help from a Luso-German cooperative program.

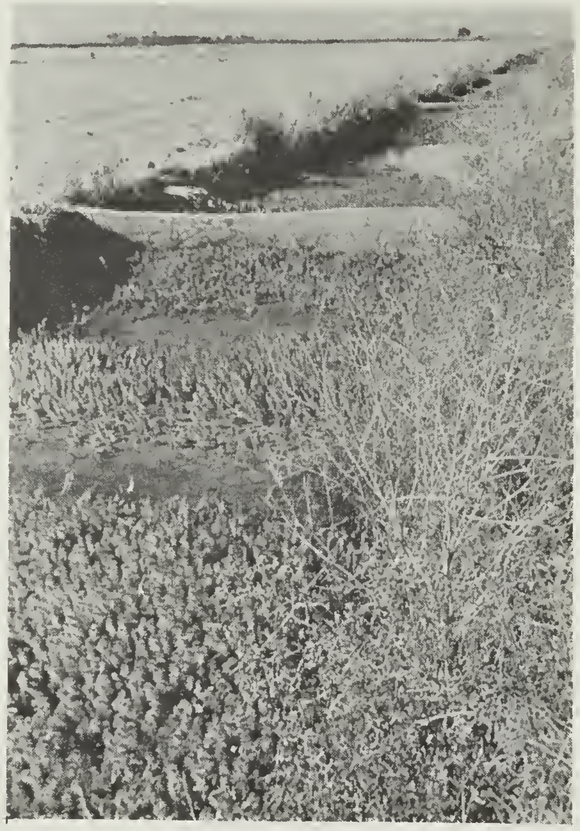
Ecological studies of the channels during 1982-83 included the studies of pH, Eh, temperature and OD profiles, transparency and conductivity, and also nutrient and heavy metal loads in the water, sediments and plant roots and shoots (3). Chemical monitoring continued up to late spring 1984 (11). The phenological cycle of major aquatic weeds also was studied in detail (3).

Mechanical harvesting till now has been the only extensive control measure used in the plain to control aquatic weeds, despite considerable financial costs. However, plant fragments produced by mechanical operations easily reinfest the areas.

Some experiences indicate waterhyacinths might be controlled by increasing water depths and flow rates, followed by controlled discharges to the main river and estuary, using nets to prevent reinfestation. Other methods, such as half-shading, are not likely to result in control because of sky brightness and long photoperiods. Several channels already have natural shade, from *Populus spp*, but no obvious growth limitation occurs.

Some herbicides have been tried in small plots since the mid-seventies against *Typha spp., Phragmites australis* and *E. crassipes.* The fairly good results have raised farmers' interest, especially in the case of common reed (6,7,8,13). The herbicides proved to be effective for control of small waterhyacinth infestations after mechanical harvesting. For toxicological reasons, glyphosate was chosen for demonstration applications on 6 km of channels to control waterhyacinth plants which remained after mechanical removal (5). A special spraying device was developed and installed on a boat. The device draws water from the channel, mixes the water with herbicide to the required dilution and applies the herbicide at various rates (4). A research program is necessary to reach a compromise between herbicide cost, efficacy and dosage before extensive spraying is initiated. There also must be assurance that herbicides will cause no water quality deterioration nor harm to the aquatic life in the channels such as plankton, macroinvertebrates and fish.

Some bioassays are being carried out to assess the growth of tomatoes, rice and melons irrigated with channel water after glyphosate treatment. First results indicate the herbicide is not harmful to the crops (12).



Experiment in a Portuguese canal using mirror carp (*Cyprinus carpio*) to control parrotfeather (*Myriophyllum aquaticum*).

The mirror carp (*Cyprinus carpio*) was found to prevent the spreading of parrotfeather. The fish disturbs the bottom mud, increases turbidity and damages plant beds; the best results seem to occur at 400 kg/ha fish density (1). The programmed introduction of grass carp (*Ctenopharyngodon idella*) to control parrotfeather has not yet been permitted by the authorities. Biological control of waterhyacinths using insects also is under consideration.

References

1. Agusti, S.; C. Duarte; T. Guimaraes. 1983. Influencia da carpa espelhada (*Cyprinus carpio* L. f. specularis Lac.) no desenvolvimento das infestantes aquaticas em valas de drenagem. I Seminario Aquacultura. Lisboa. (In press.)
2. Duarte, C.; S. Agusti; I. Moreira. 1984. Water hyacinth (*Eichhornia crassipes* Mart. Solms) and watermilfoil (*Myriophyllum aquaticum* (Vell.) Verdc.) in Portugal. Proc. EWRS 3rd Symp. Weed Problems Mediterranean Area. 3:667-674.
3. Duarte, C.; S. Agusti. 1985. Ecologia de la invasion de canales de irrigacion por macrofitas aquaticas. CBAA, 58 pp.
4. Fernandes, E. 1985. Pulverizador montado em barco para aplicacao de herbicidas em valas. (In press.)
5. Fernandes, E.; J.D. Fernandes; I. Moreira. 1981. Ensaio preliminar extensivo de aplicacao de herbicidas para controlo do jacinto aquatico em valas. DGPPA e CBBA. 8 pp.
6. Fernandes, E.; I. Moreira. 1985. Ensaios da luta quimica para o controle de infestantes aquaticas. DGPPA e CBAA. 12 pp.
7. Fernandes, J.D.; A.R. Guerreiro; T. Vasconcelos; I. Moreira. 1978. Essais de lutte contre les plantes aquatiques au Portugal. Proc. EWRS 5th Symp. Aquatic Weeds. Pp. 189-194.
8. Fernandes, J.D.; T. Vasconcelos; J.M. Martins. 1980. Luta quimica contra o canico (*Phragmites australis* (Cav.) Trin. ex Steudel). I Cong. Port. Fitiatria Fitofarmacologia 4:173-180.
9. Ferreira, M.T.; S. Agusti; S. Duarte. 1984. Phytoplankton in Lezira Grande channels—preliminary results. Centro Bot. Apl. Agric. 4 pp.
10. Figueiredo, J.; C. Duarte; I. Moreira; S. Agusti. 198 . As infestantes aquaticas no sistema de irrigacao e drenagem do Ribatejo. Recursos Hidricos 5(1):5-14.
11. Fonseca, P.C. 1984. Estudo ecologico de valas da Leziria Grande de Vila Franca de Xira. Escola Sup. Agraria Santarem, CBAA. 93 pp.
12. Monteiro, A. 1984. Primeiros ensaios sobre a fitotoxidade do glifosato aplicado em valas. CBBA. 7 pp.

Portuguese herbicide trial to control *Eichhornia crassipes* in canals with glyphosate.

SOCIAL CONSEQUENCES OF SALVINIA INFESTATIONS IN PAPUA NEW GUINEA

Problems caused by aquatic weeds are usually defined in terms of navigation, recreation, irrigation and flood control and so on. Social consequences of aquatic weed infestation are rarely described. Recently, a very interesting account of "catastrophic" social consequences brought about by a *Salvinia molesta* infestation was published. The book was brought to our attention by D.S. Mitchell of CSIRO-Australia. The account is in SEPIK RIVER SOCIETIES—A HISTORICAL ETHNOGRAPHY OF THE CHAMBRI AND THEIR NEIGHBORS by Deborah B. Gewertz. (Yale University Press, New Haven, Connecticut. 1983.) For part of her studies, Ms. Gewertz had intended to study the sex roles of the Chambri people of Papua New Guinea, but after realizing the significance of the weed infestation, she changed her plans in order to "analyze the social processes associated with the introduction of *Salvinia* as objectively as possible."

The account is about the Chambri people, hunter-gatherers living on the shores of the Sepik River which, in the early 1970s, became choked with dense mats of the floating fern. Chapter 10 of her book is titled *Salvinia molesta:* The Destruction of an Ecosystem.

Gewertz recounts how the plant quickly spread to cover 79 kilometers of the river and 90% of Chambri Lake, affecting nearly 35,000 people who grow no crops, subsisting entirely by fishing and trading for sago palm.

The author examines the effects of the infestation on the economy of the people, and analyzes where and how villagers have placed blame for the problem. According to Gewertz, the plants entirely covered village fishing grounds, making it impossible to use fish nets. The women, traditionally responsible for catching fish for their families, return from the lake without enough food to feed their families. Sago, another staple of the economy, grows primarily in groves on the opposite side of the lake and river. Canoeing in the ferns is nearly impossible, and villagers have been trapped among the weeds in the middle of the water.

The Chambri economy has been drastically altered by the presence of *Salvinia*. No longer do the Chambri have enough fish to exchange for sago. Because food supplies were greatly reduced, almost 50 percent of the population left their lake-side village for refuge in the town of Wewak. The remaining people face starvation.

The social stresses extend far beyond the obvious level of not having enough to eat. Because "nothing in Chambri experience has prepared them for *Salvinia molesta,*" villagers have assigned various causes for the plague of "the no-good grass." Gewertz quotes a villager as saying that the weeds came "because the people had disobeyed God's commandments and God sent this weed into the area to make people suffer and be punished." Members of other nearby tribes blame the infestation on the "weakness of Chambri ancestors."

The Chambri women are blamed by the men who believe the food shortage is because the women do not maintain clear-cut allegiances and give food to the wrong people, or simply because the women do not work hard enough.

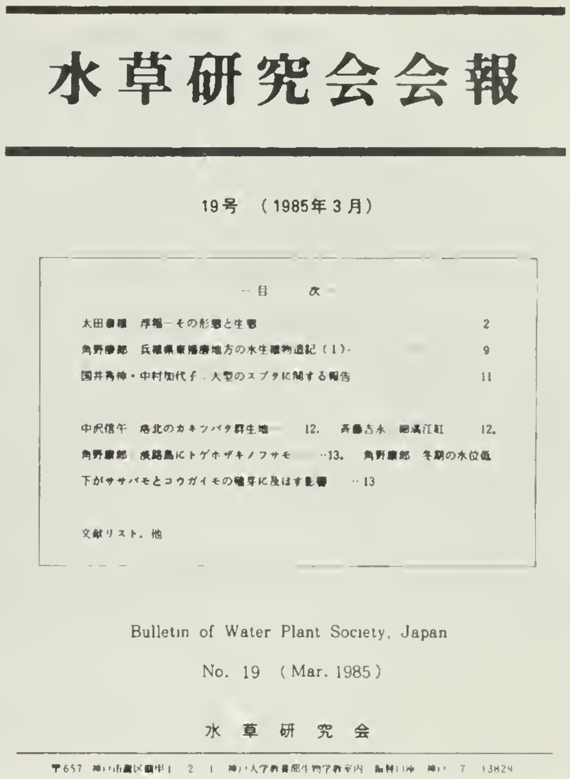
Gewertz also describes how the villagers engage in "weed warfare": planting the weed in fishing grounds and gardens of family and village enemies.

WATER PLANT SOCIETY OF JAPAN

The Water Plant Society of Japan was founded in 1980 for promotion of scientific research, exchange of information and propagation of the knowledge of water plants. The society has about 240 members including professional researchers, amateur botanists and general fanciers of plants. The society's interests include the study of taxonomy, ecology and physiology of water plants, weed control, utilization of water plants as class materials in schools, environmental conservation and cultivation for ornamental purposes.

The Society publishes the Bulletin (in Japanese) quarterly. The bulletin contains reports of studies, reviews of current topics, essays and lists of publications on water plants which appear in Japan.

Annual membership fees are 2,500 yen. For more information, write to Dr. Yasuro Kadono, Secretary, Water Plant Society, Department of Biology, College of Liberal Arts, Kobe University, Nada, Kobe 657, JAPAN.



水草研究会会報

19号 （1985年3月）

Bulletin of Water Plant Society, Japan

No. 19 (Mar. 1985)

水 草 研 究 会

NOTICE

The Aquatic Weed Program continues to provide information services to users in the United States.

However, because of the lack of an international sponsor, the program is unable to provide these services to users outside the United States. We are pursuing international support and welcome any suggestions as to how to fund services for clients in other countries. The program is not able to bill or receive payments on a "per use" basis. (See INTERNATIONAL SPONSOR NEEDED for more information.)

ECONOMIC LOSS...

(Continued from page 1)

Research cited here was conducted by D.E. Colle, J.V. Shireman and D.E. Canfield of the Department of Fisheries and Aquaculture and by W.T. Haller and J.C. Joyce of the Center for Aquatic Weeds.

ARMY CORPS...

(Continued from page 2)

federal. Public law 89-298 limits the Corps National APCP budget to $10 million annually.

RESEARCH

The Corps of Engineers Waterways Experiment Station (WES), Vicksburg, Mississippi, is conducting research under the Aquatic Plant Control Program to develop improved methods of mechanical, chemical and biological control. Each of these methods possesses its own advantages and disadvantages; however, by using each method effectively, the overall control program will be more cost effective and environmentally compatible.

For more information, contact: Natural Resources Management Section, Construction Operations Division, U.S. Army Corps of Engineers, P.O. Box 4970, Jacksonville, Florida, 32632, USA. (904) 791-2215, or Waterways Experiment Station, Corps of Engineers, P.O. Box 631, Vicksburg, Mississippi, 39180-0631, USA.

(Continued from page 3) SALVINIA...

that these successes will be repeated in the water development project in Sri Lanka.

Agencies which have provided Sri Lanka assistance against this new problem include: The Commonwealth Science Council, London; The Commonwealth Institute of Biological Control, India; The CSIRO Long Pocket Laboratories, Australia; The International Development Research Centre, Canada; and the Aquatic Weed Program, University of Florida, Gainesville.

The following list of *Cyrtobagous* research was retrieved from the Aquatic Weed Program's aquatic plant database.

Boland, N.P.; P.M. Room. 1983. Estimating population density of a *Cyrtobagous* sp. (Coleoptera, Curculionidae) on the floating weed *Salvinia* using Berlese funnels. J. Australian Entomological Soc. 22(4):353-354.

Forno, I.W.; A.S. Bourne. 1986. Temperature-related effects of three insects on growth of *Salvinia molesta* in Brazil. Entomophaga 31(1):19-26.

Forno, I.W.; A.S. Bourne. 1984. Studies in South America of arthropods on the *Salvinia auriculata* complex of floating ferns and their effects on *S. molesta*. Bull. Ent. Res. 74(4):609-621.

Forno, I.W.; D.P.A. Sands; W. Sexton. 1983. Distribution, biology and host specificity of *Cyrtobagous singularis* Hustache (Coleoptera: Curculionidae) for the biological control of *Salvinia molesta*. Bull. Ent. Res. 73(1):85-96.

Kissinger, D.G. 1966. *Cyrtobagous hustache*, a genus of weevils new to the United States fauna (Coleoptera: Curculionidae: Bagonini). The Coleopterists' Bull. 20:125-127.

Room, P.M.; P.A. Thomas. 1985. Nitrogen and establishment of a beetle for biological control of the floating weed *Salvinia* in Papua New Guinea. J. Appl. Ecol. 22(1):139-156.

Room, P.M.; K.L.S. Harley; I.W. Forno; D.P.A. Sands. 1981. Successful biological control of the floating weed *Salvinia*. Nature 294(5):78-80.

Room, P.M.; I.W. Forno; M.F.J. Taylor. 1984. Establishment in Australia of two insects for biological control of the floating weed *Salvinia molesta*. Bull. Ent. Res. 74(3):505-516.

Sands, D.P.A.; M. Schotz; A.S. Bourne. 1983. The feeding characteristics and development of larvae of a *Salvinia* weevil *Cyrtobagous* sp. Ent. Exp. & Appl. 34(3):291-296.

Sands, D.P.A. 1984. Identity of *Cyrtobagous* sp. (Coleoptera: Circulionidae) introduced into Australia for biological control of *Salvinia*. J. Aust. Ent. So.
22:200.

AQUATIC MACROPHYTES IN RIO GRANDE DO SUL STATE, BRAZIL

by Gilberto Pedralli, Setor de Ecossistemas, Fundacao Centro Tecnologico de Minas Gerais (CETEC); Av. Jose Candido da Silveira, 2000; CEP 31.170—Belo Horizonte—MG; BRAZIL.

The State of Rio Grande do Sul has the greatest lacustrine complex in Brazil. There are many lakes and lagoons, rivers and creeks, many of which are linked together and/or linked with the Atlantic Ocean.

Since 1976, a team of researchers has been collecting and identifying aquatic macrophytes throughout the State. Team members are from the Universidade Federal de Pelotas (UFPEL) and Universidade Federal do Rio Grande do SUl (UFRGS). They receive the support of Conselho Nacional de Desenvolvimento Cientifico e Technologico (CNPq), Fundacao de Amparo a Pesquisa do Estado do Rio Grande do Sul (FAPERGS) and Comissao Interministerial de Recursos do Mar (CIRM).

After identification, the collected species are classified according to 7 principal biologic varieties: amphibians, rooted floating, free floating, rooted submergents, free submergents, emergents and epiphytes.

Team members have identified 126 species belonging to 53 familes and 95 genera in the region between the municipal districts of Chui and Rio Grande, near the Taim Ecological Station of the Secretaria Especial do Meio Ambiente (SEMA). 85 species of 41 families and 66 genera were identified between the municipal districts of Sao Jose do Norte and Viamao. 70 species of 43 families and 66 genera were found in the region between Tramandai and Torres.

The final results of these floristic studies will be published in a manual of "Aquatic Macrophytes", that will contain identification keys, illustrations, ecological observations and maps of the geographic distribution of the species.

The partial and final lists (including all the State of Rio Grande do Sul) can be acquired at the above address.

AQUATIC WEEDS AND COLOMBIAN HYDROELECTRIC PROJECTS

Colombia is a country well suited for the development of hydroelectric power plants. Colombia also is well suited for the development of major aquatic weed infestations which can cover reservoirs and interfere with dams, their water intakes and discharge gates.

In Cordoba State, two major power plants, URRA I and URRA II, are being built at the confluence of several rivers where two reservoirs with a total area of more than 600 square kilometers are being created. The power plants together will have a capacity to produce 5,000 gigawatts of energy per year.

To minimize the effects of aquatic weeds on the project, researchers of the Corporacion Electrica de la Costa Atlantica (CORELCA) are devising a management plan to control aquatic weeds before they create major hazards.

Initial steps include studying the effects of aquatic weeds on similar projects in other countries. They also are identifying species, studying their ecology, growth and population dynamics, and locating their sources throughout the river systems. Finally, they are collecting information on the methods of prevention and control of species expected to proliferate in the reservoirs.

Of the 32 species of aquatic plants common to the rivers of the area, three species have been identified as weeds of major concern. They are the waterhyacinth (*Eichhornia crassipes*), water lettuce (*Pistia stratiotes*) and salvinia (*Salvinia auriculata*).

For more information on the project and their aquatic plant studies, contact: Sr. Eustorgio Caro Sierra, Director, Regional Hydroelectric Project of URRA, CORELCA, Edificio Centro Ejecutivo II Carrera 55, No. 72-109 Piso 9 Apartado Aereo No. 2741, Barranquilla, COLOMBIA.

NOTICE

See **INFORMATION EXCHANGE HALTED...** on page one.

MEETINGS

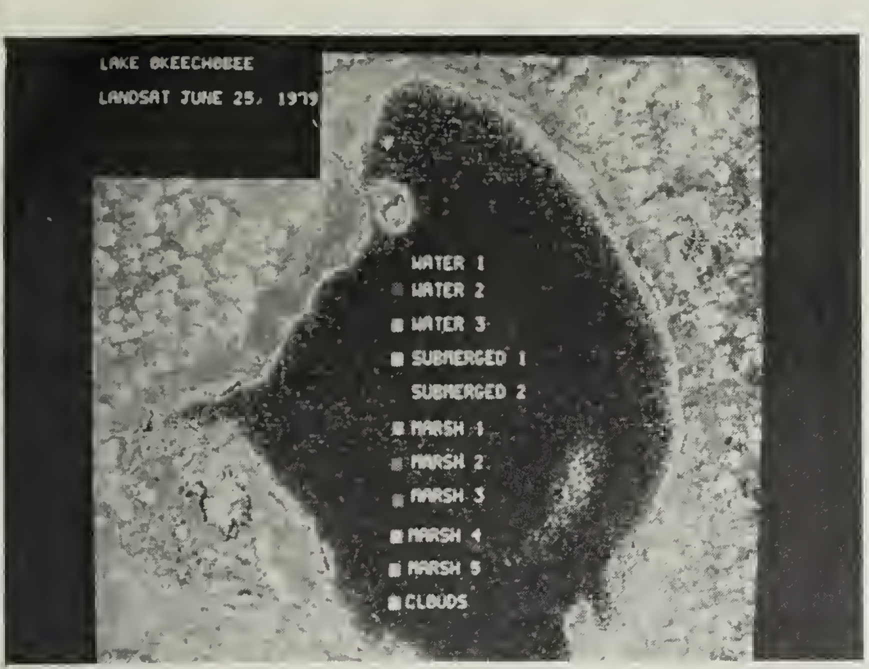
SEVENTH INTERNATIONAL SYMPOSIUM ON AQUATIC WEEDS. September 15-19, 1986, Loughborough, ENGLAND. The symposium is sponsored by the European Weed Research Society (EWRS) and the Association of Applied Biologists (AAB). The symposium theme is "The Biology and Control of Aquatic Weeds". For information, contact: Dr. Max Wade, Department of Human Sciences (Ecology Group), Loughborough University of Technology, Loughborough, Leicestershire LE11 3TU, ENGLAND.

INTERNATIONAL CONFERENCE ON BIOMANIPULATION OF NATURAL AND ARTIFICIAL WATER BODIES. Summer, 1987. Lake Kinneret, ISRAEL. The conference is organized by the Israel Oceanographic and Limnological Research Co. For information, contact: Dr. Moshe Gophen, Chairman, Organizing Committee, The Yigal Allon Kinneret Limnological Laboratory, P.O.B. 345, Tiberias, ISRAEL 14-102.

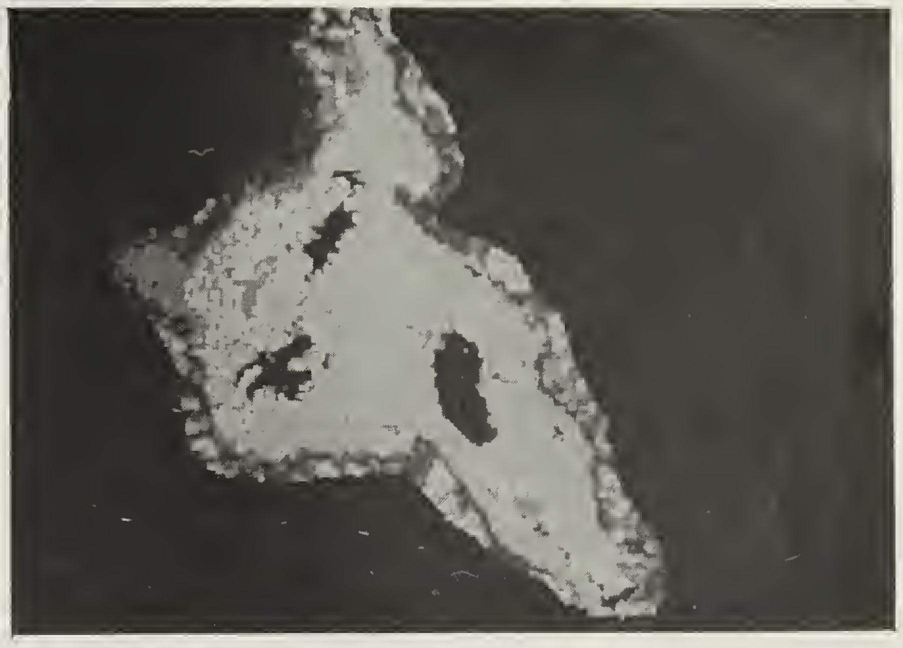
Biomanipulation, the management of aquatic communities by controlling natural populations of organisms to produce desired conditions, is a field of growing interest. Although research to date shows varying degrees of success, evidence suggests that it is sometimes possible to greatly improve water quality, productivity (fishery), and overall community structure by enhancing or reducing populations of relatively few target species. The Conference will bring together researchers from different areas of limnology, fisheries, and aquatic resource management for an exchange of information and ideas to stimulate interest in biomanipulation of lakes, rivers and reservoirs. The scope of the conference will include the control and management of water quality, plankton, benthos, and macrophyte and fish populations.

FLORIDA AQUATIC PLANT MANAGEMENT SOCIETY ANNUAL MEETING. October 13-16, 1986. Plant City, Florida. Contact: Mr. David Tarver, President FAPMS, 2416 McWest Street, Tallahassee, Florida 32303. (904) 562-1870.

Personnel from the Center for Aquatic Weeds recently cooperated in a residue study with the Dow Chemical Company and the Army Corps Waterways Experiment Station. The study took place on Lake Seminole, a 37,000 acre reservoir on the borders of Florida, Georgia and Alabama. Part of the study was to determine the uptake and effects of the herbicide Garlon (triclopyr) on crayfish and freshwater clams. Here, Dr. Joe Joyce delivers crayfish cages to the study area. Dr. Howard Westerdahl was the principal investigator for the study. Westerdahl is the section chief, Aquatic Processes and Effects, Environmental Laboratory, Waterways Experiment Station, Vicksburg, Mississippi.



Lake Okeechobee, Florida. Plant communities reflect unique wavelengths. Computer "enhancement" can produce images which show only the plants of interest. Using plotting equipment, plant coverage can be calculated.



Lake Miccosukee, Florida. The image shows "surprising accuracy" in discriminating many plant communities, and in fact displays more detail than can be discriminated on the ground. For this image, the computer was programmed to ignore data outside the lake's boundary.

REMOTE SENSING OF FLORIDA

Remote sensing with satellites is a state-of-the-art tool which is being used to survey and catalog everything on the planet's surface. With satellite images, agronomists diagnose food crop health and compute acreages, geologists discover and map geologic faults and meteorite craters, foresters survey and identify diseased forests and hydrologists observe delta formation and measure temperature zones in the oceans. Since the early 1970s, satellite images have been used to map wetlands, determine water quality of lakes, determine surface areas of water bodies, and so on. Recently, researchers have employed satellite technology for yet another task.

Now, aquatic plant managers are studying the potential of satellite images to help survey aquatic vegetation in lakes and rivers. Remote sensing could provide an easier and cheaper method to anticipate and prevent spread and infestations of nuisance species. Thus, environmental and economic impacts of these infestations could be reduced.

Photograph-like images of earth taken by satellites show much more detail than the eye can see. These images are digital (dot-by-dot) recreations of computer measurements of wave-lengths reflected from the earth's surface. Images can be "enhanced" by computers by specifying wave-lengths corresponding to whatever the viewer wishes to see. For example, an image of hydrilla infestation in a lake can be produced by telling the computer to produce an image using only the reflectance wave-length of hydrilla. This ability coupled with satellite imagery's very high resolution has made satellite photographs a tool for earth-bound researchers. As accurate as these images are now, technical developments promise even higher resolutions in the future. Perfecting techniques now will make it much easier to use the next generation of satellite images.

The Florida Department of Natural Resources has a program to study the use of satellite imagery for aquatic plant management. DNR's Larry Nall has produced enhanced color-coded images which differentiate several species of aquatic plants in Florida lakes. Floating, emergent and submersed plants are represented by specified bits of colors in these images.

Nall began his work in remote sensing to improve the accuracy and reduce the time required to conduct the department's aquatic plant surveys of Florida. The 1983 survey covered 1,401,511 acres of water and took 8½ months to complete. These surveys require many hours of work but are an important part of DNR's job of managing Florida's water resources.

Another goal of Nall is to reduce the cost of surveying. Aerial photography used in surveys is expensive because of aircraft rental, flight crew wages and specialized photographic materials. Digital processing of the photographs also is quite expensive, requiring computer equipment and technical assistance. Satellite imagery is comparatively inexpensive. The satellite provides complete and frequently repeated images of most areas worldwide through a largely automated process. Data from satellite images requires only a mini-computer for processing.

LANDSAT IMAGES

One Landsat scene is approximately 115 miles square. Twelve images cover the entire state of Florida.

Landsat cameras are of three types: the Vidicon, the Multispectral Scanner (accurate to 0.6 acres) and the Thematic Mapper (accurate to 0.2 acres). Future cameras will have even higher resolutions.

Specific wave-lengths can be assigned true colors, false colors or black and white, making the images very useful for rapid identification of different plant populations.

Nall has determined that the current minimum acceptable size for accurate sensing of aquatic plants from Landsat is about 500 acres. With today's satellite technology, Landsat probably is acceptable only for larger lakes— over 100 acres—and for large populations of plants. This limitation should be overcome as more sophisticated satellites with higher resolution cameras become available to the public.

Unprocessed photographs show almost no vegetation in lakes. "Enhancing" brings out wave-lengths which correspond to specific reflectance of species.

Acreages can be determined by a computer plotter-counter. Precise fixed-point transects initially will have to be conducted to correlate the signature (wave-length) with plant species. Ground-truthing (verifying plant species on the ground) should take place on the day of the LANDSAT flyover.

Advantages of surveying large systems such as Lake Okeechobee are obvious. Biologists will only have to visit certain areas to confirm the identity of plants, and the computer can then quantify those areas which correspond to that plant's wave-length.

SOME RESULTS

Nall found that many classes of marginal and floating plants were detected using Landsat data. Landsat data generally corresponded well with known aquatic plant communities. Several classes of submersed plants also were detected and good penetration of moderately clear water was demonstrated.

Using the multispectral scanner camera data, Nall found the cost for coverage of the entire state is about $7,800. The cost of using thematic mapper data is substantially higher: about $38,400. Therefore, a survey of one million acres of water using multispectral scanner data would cost about $.0078 per acre; thematic mapper data would cost about $0.0384 per acre.

Nall believes Landsat data can be used economically and conveniently to survey emersed and submersed plants. Nall's future work will be to collect data to produce a detailed processing procedures manual so that satellite imagery can be used routinely.

For this work, Nall used DNR's Landsat analysis facility at the St. Petersburg Marine Laboratory (Gould computer, Comptal image processing system and ELAS software from NASA) and magnetic tapes of Florida images obtained from Landsat satellites. Nall's address is: Mr. Larry Nall, Florida Department of Natural Resources, Bureau of Aquatic Plant Management, 3900 Commonwealth Boulevard, Tallahassee, Florida 32303. Landsat photographs and magnetic tapes can be obtained from the U.S. Geological Survey, Earth Resources Observation Station (EROS) in South Dakota.

REPORTS

RESPONSES OF SUBMERSED VASCULAR PLANT COMMUNITIES TO ENVIRONMENTAL CHANGE. by G.J. Davis and M.M. Brinson. 1980. U.S. Department of the Interior, Fish and Wildlife Service, Office of Biological Services, Washington, D.C. FWS/OBS-79/33. 79 pages. Order from: Information Transfer Specialist, U.S. Fish and Wildlife Service, Eastern Energy and Land Use Team, Route 3, Box 44, Kearneysville, West Virginia 25430 USA.

This review of the literature about environmental effects on the biology of submersed plants pays particular interest to plants' photosynthetic responses to light attenuation, turbidity and depth. Other environmental factors considered are fluctuating water levels, currents and waves, turbidity, dormancy, nutrient availability, and hydrostatic pressure. Also considered are community structure changes related to natural and man-made short-and long-term stresses.

A FARMER'S PRIMER ON GROWING RICE by B.S. Vergara. 1979. International Rice Research Institute (IRRI), Communication and Publications Department, P.O. Box 933, Manila, PHILIPPINES. 221 pages.

Published in 25 languages, this book clearly and simply explains the "why" and "how" of good rice-growing practices. (It is being translated into 20 other languages.) The primer was written for IRRI students and trainees from developing countries to explain through black and white illustrations how to incubate seeds, how to determine proper depth for transplanting and so on. IRRI believes the book is the most widely translated agricultural book in existence.

ECOLOGICAL ASSESSMENT OF MACROPHYTON. Collection, Use, and Meaning of Data. Ed. by W.M. Dennis and B.G. Isom. 1984. Special Technical Publication 843, American Society for Testing and Materials (ASTM), 1916 Race Street, Philadelphia, Pennsylvania 19103 USA. 122 pages.

This is a collection of twelve papers presented at an ASTM symposium in Ft. Lauderdale, Florida in January 1983. Most of the papers are about methods for sampling and quantifying macrophyte vegetation in the field, but others have to do with mapping and the use of remote sensing and aerial photography to monitor aquatic plants.

CULTURE METHODOLOGY FOR EXPERIMENTAL INVESTIGATIONS INVOLVING ROOTED SUBMERSED AQUATIC PLANTS. by R.M. Smart and J.W. Barko. 1984. Army Corps of Engineers, Waterways Experiment Station, P.O. Box 631, Vicksburg, Mississippi 39180-0631, USA. Miscellaneous Paper A-84-6. 20 pages.

This information is intended to help in culturing submersed plants for experimental laboratory research. Formulas are given for a general purpose culture solution and an ionically balanced, alkaline solution. Research on nutrient sources and uptake is reviewed.

AQUATIC BIOTA OF LATIN AMERICA. Vol. I. Aquatic Biota of Southern South America, ed. by S.H. Hurlbert, 1977, 342 pp. **Vol. II. Aquatic Biota of Tropical South America**, ed. by S.H. Hurlbert, G. Rodriguez and N.D. Santos; **Part 1. Arthropoda**, 1981, 323 pp.; **Part 2. Anarthropoda**, 1981, 298 pp. **Vol. III. Aquatic Biota of Mexico, Central America and the West Indies**, ed. by S.H. Hurlbert and A. Villalobos-Figueroa, 1982, 529 pp. Vol. 1, $13.00. Vol II, Part 1, $14.00. Vol II, Part 2, $12.00. Vol III, $20.00. Contact: Dr. Stuart H. Hurlbert, Department of Biology, San Diego State University, San Diego, California 92182, USA.

This 3-volume work is "the only general reference work on the freshwater biota of the neotropics" and was produced through the collaboration of 150 taxonomists supported by institutes in Brasil, Mexico, the United States and Venezuela. "Each volume contains annotated taxonomic bibliographies treating all plant and animal groups found in the inland waters of the region. Introductions summarize information on taxonomy, biogeography and natural history and guide the reader to the taxonomic literature."

THE AUSTRALIAN WEED CONTROL HANDBOOK: SEVENTH EDITION. ed. by J.T. Swarbrick. 1984. A$13.00 plus postage for each handbook. Order from: Plant Press, 3A Ipswich Street, Toowoomba, Queensland 4350, AUSTRALIA.

This is the standard Australian reference book on the control of weeds in horticultural and agricultural crops, pastures, and industrial and aquatic situations. It includes sections on methods of control and herbicide application and safety. Detailed information on the active ingredients, registration status, uses, mixing, timing, application and weeds controlled by 145 herbicides is presented. Indexes to products and plants are included.

WATER LILIES OF THE UKRAINE. by D.V. Dubyna. 1982. Academiya Nauk Ukraine SSR, Institute of Botany, N.G. Kholodnovo, Kiev. 230 pages. (In Russian)

This is an extensive review of research on the ecology and biology of water lilies, drawing especially on the large body of Soviet literature. Sections review the taxonomy of water lilies, the distribution of species in the Ukraine, plant and seed morphology, growth and habitat requirements and plant associations.

THE UTILIZATION OF EMERGENT AQUATIC PLANTS FOR BIOMASS ENERGY SYSTEMS DEVELOPMENT. by S. Kresovich, C.K. Wagner, D.A. Scantland, S.S. Groet and W.T. Lawhon. 1982. Battelle Columbus, for the Solar Energy Research Institute and for the U.S. Department of Energy. 115 pages. NTIS No. DE82009174.

This study was made to assist in developing emergent aquatic biomass energy systems. It reviews the literature to identify plants which might be managed and genetically manipulated. They determined that species of particular interest are *Arundo donax, Cyperus papyrus, Phragmites communis, Saccharum spontaneum, Spartina alterniflora* and *Typha latifolia.*

CARPINTERIA SALT MARSH: ENVIRONMENT, HISTORY AND BOTANICAL RESOURCES OF A SOUTHERN CALIFORNIA ESTUARY by W.R. Ferren, Jr. 1985. Publication No. 4, The Herbarium, Department of Biological Sciences, University of California, Santa Barbara, Santa Barbara, California 93106. 300 pages. $15.00.

CERCOSPORA RODMANII CONWAY; A BIOCONTROL AGENT FOR WATERHYACINTH by T.E. Freeman and R. Charudattan. 1984. Technical Bulletin #842, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, Florida. 18 pages. Free.

This is a technical review of the use of pathogen, *Cercospora rodmanii*, against waterhyacinth. Information on disease symptoms, morphology of *Cercospora*, culturing and cultural characteristics, infection and pathologocial histology, epidemiology, biocontrol potential, safety, and potential for practical use is presented.

PROCEEDINGS OF THE SYMPOSIUM ON THE OKAVANGO DELTA AND ITS FUTURE UTILIZATION. 30 August to 2 September 1976, Gaborone, Botswana. Organized by The Botswana Society and the National Museum, Gaborone, BOTSWANA. Published by the Okavango Wildlife Society, P.O. Box 52362, Saxonwold, Johannesburg, 2132, SOUTH AFRICA. 350 pages.

The purpose of the Symposium was to gather as much information as possible on the Okavango Delta for the use of planners and policy-makers. This collection of the 32 papers presented at the Symposium includes information on the delta's geology and history, weather and development as well as ecological information on the delta. Sections on man's role and use of the delta, and the potential development and development's effects on the delta in the future are presented.

VEGETATIVE MANAGEMENT OF FRESHWATER RESOURCES by E.O. Gangstad. 1986. Thomson Publications, P.O. Box 9335, Fresno, California 93791. $35.00.

This book reviews the chemical control of aquatic plants, and presents information on the herbicidal, environmental and health effects of eleven aquatic herbicides. Fisheries management is also reviewed.

COASTAL WETLANDS. PROCEEDINGS OF THE FIRST GREAT LAKES COASTAL WETLANDS COLLOQUIUM 5-7 November 1984, East Lansing, Michigan. 1985. Edited by H.H. Prince and F.M. D'Itri. Lewis Publishers, Inc., 121 South Main Street, P.O. Drawer 519, Chelsea, Michigan 48118. 285 pages.

The theme of the Colloquium was "Natural and Manipulated Water Levels in Great Lakes Wetlands." The proceedings is "intended to provide fisheries and wildlife biologists, ecologists, aquatic resource managers and planners and environmental scientists information about the coastal wetlands in regard to eight priority areas." Papers on the effects of water level fluctuations on marshes, seed beds, population dynamics, nutrient cycling and marsh animals are presented.

AQUATIC WEEDS—UTILITY AND DEVELOPMENT. by F.Z. Majid. 1986. Agro Botanical Publishers, Old Ginnani, Bikaner, 334 001, INDIA. $20.00

This book reviews the latest developments in aquatic weed control for farmers, traders and industrialists and those who are concerned with weed management, irrigation and fisheries.

PROCEEDINGS, FIRST INTERNATIONAL SYMPOSIUM ON WATERMILFOIL AND RELATED HALAGORACEAE SPECIES. held July 23, 1985, Vancouver, British Columbia. Order from Mr. Bill Rushing, P.O. Box 16, Vicksburg, Mississippi 39180. $15.00.

ECOSYSTEM DYNAMICS IN FRESHWATER WETLANDS AND SHALLOW WATER BODIES. Proceedings of the International Scientific Workshop, 12-26 July 1981, Minsk-Pinsk-Tskhaltoubo, USSR. Compiled by D.O. Logofet and N.K. Luckyanov. Volume 1, 1982, 312 pages. Volume 2, 1982, 424 pages. Sponsored by the United Nations Environment Programme (UNEP) and the Scientific Committee on Problems of the Environment (SCOPE). Published by the Centre of International Projects GHNT, Moscow.

These are the proceedings of the first of a number of planned workshops for this UNEP/SCOPE wetlands project. Topics discussed here: 1)Ecological, botanical, zoological and hydrological studies, 2)Methodology, theory and practice of modelling ecosystem dynamics and their applications to wetlands, and 3)Using wetlands in relation to national economies. Volume I includes 17 papers devoted to general and specific problems of wetland ecology and case studies from around the world. Volume II contains 21 papers on modelling and economic development of wetlands.

WETLANDS FOR WASTEWATER TREATMENT WITH SPECIAL REFERENCE TO MUNICIPAL WASTEWATER by F.E.J. Rogers, K.H. Rogers and J.S. Buzer. 1985. Witwatersrand University Press, 1 Jan Smuts Avenue, 2001 Johannesburg, SOUTH AFRICA. 122 pages.

This is a two-part review which "introduces wetland ecosystems and then discusses the processes involved in wetland wastewater treatment and the potential for management of such systems." The aim of the review is to provide researchers and managers with an overview on how wetlands might improve water quality and how effective they might be and to discuss cost-effectiveness of wetland wastewater treatment systems. The review also seeks to help determine priorities for future research in this area.

AQUARIUM PLANTS. Their Identification, Cultivation and Ecology. by K. Rataj and T.J. Horeman. 1977. T.F.H. Publications, Inc., Neptune City, New Jersey 07753, USA. 448 pages.

This book describes principles for the cultivation of aquatic plants in aquariums, and includes information on the reproduction and propagation of plants and the set-up and care of aquariums. Many species are described and pictured in hundreds of color and black/white pictures. Indexes of scientific and popular names are included.

THE ECOLOGY AND MANAGEMENT OF AFRICAN WETLAND VEGETATION. A Botanical Account of African Swamps and Shallow Waterbodies. Geobotany; 6. edited by P. Denny. 1985. Dr. W. Junk Publishers, P.O.B. 163, 3300 AD Dordrecht, THE

NETHERLANDS. 376 pages. $78.50

This is a collection of papers on the aquatic vegetation of Africa. It includes parts on water plant biology, vegetation dynamics, and ecosystem structure and functioning. It concludes with a cross-indexed bibliography of African aquatic plants. Contributors include P. Denny, K. Thompson, C. Howard-Williams, J.J. Gaudet, and D.S. Mitchell.

A PALAEOHYDROLOGICAL STUDY OF KRAGEHOLMSSJON (SCANIA, SOUTH SWEDEN). Regional Vegetation History and Water-Level Changes. by M.-J. Gaillard. 1984. Lundqua Report No. 25, Lund University, Department of Quaternary Geology, Tornavagen 13, S-223 63 Lund, SWEDEN. 40 pp.

This study uses pollen analysis and plant macrofossil analysis to determine the human impact and water-level changes in a southern Sweden lake since Neolithic times.

FRESWATER PLANTS OF PAPUA NEW GUINEA. by G.J. Leach and P.L. Osborne. 1985. The University of Papua New Guinea Press, The University Bookshop, P.O. Box 114, University P.O., N.C.D., PAPUA NEW GUINEA. About $22.00.

This is a key to the families of macroalgae, ferns and flowering freshwater plants of Papua New Guinea. Each section consists of a family description, key to genera, generic descriptions, key to species, species descriptions, notes on taxonomy, distribution and habitat and full specimen citations. Included are line drawings and color plates.

ETNOFLORA YUCATANENSE. Lista Floristica y Sinonimia Maya. by V. Sosa, J. Salvador Flores, V. Rico-Gray, R. Lira and J.J. Ortiz. 1985. Instituto Nacional de Investigaciones sobre Recursos Bioticos (INIREB), Apdo. Postal 63, Xlapa, Veracruz 19000, MEXICO. (In Spanish).

This is a floristic list (with synonymy) of the higher plants of the Yucatan peninsula. It includes a list of common plant names.

PROCEEDINGS, 2ND INTECOL WETLANDS CONFERENCE held at Trebon, Czechoslovakia, 13-23 June 1984. Czechoslovak Academy of Sciences, Institute of Botany, Department of Hydrobotany, 379 82 Trebon, Dukelska 145, CZECHOSLOVAKIA.

More than 120 researchers from 26 countries attend the 2nd INTECOL Wetlands Conference. 75 papgers were presented. Several publications have resulted from the 2nd INTECOL Wetlands Conference. Besides the full Proceedings, other publications include: Wetland Soils and Microclimate; World Inventory of Wetlands; Management of Wetlands; Wetland Plant Adaptations; Modelling of Wetland Ecosystems; Carex-Dominated Wetlands; and Reed-Death: *Phragmites* Decline in Lake Littorals. Contact Dr. Jan Kvet, Dr. Jan Pokorny or Dr. Dagmar Dykyjova at the above address.

AQUATIC HERBICIDE RESIDUE LITERATURE REVIEW
by J.C. Joyce and V.A. Ramey. Report, Center for Aquatic Weeds, University of Florida, Gainesville. 1986. 50 pp.

This report identifies research on the fate of aquatic herbicides in water, especially research relevant to Florida's freshwater ecosystems. The report includes research on 2,4-D, fluridone, endothall, diquat, copper and glyphosate.

A MONOGRAPH OF VASCULAR HYDROPHYTES IN KOREAby Hong Keun Choi. Ph.D. Dissertation, Seoul National University, Korea. 1986. 288 pp. (In Korean)

The author presents a taxonomic analysis of 71 plants inhabiting the five main rivers in Korea. Included is new information on *Isoetes* and *Trapa* species.

"MAINTENANCE CONTROL"

"Maintenance control" of aquatic plants is an official policy of the State of Florida, and state regulatory agencies have been mandated to implement maintenance control methods in their aquatic plant management operations. The objective of maintenance control is not the eradication of problem plants. Because of high economic and environmental costs of very intensive chemical and/or mechanical operations, complete eradication is considered practically impossible.

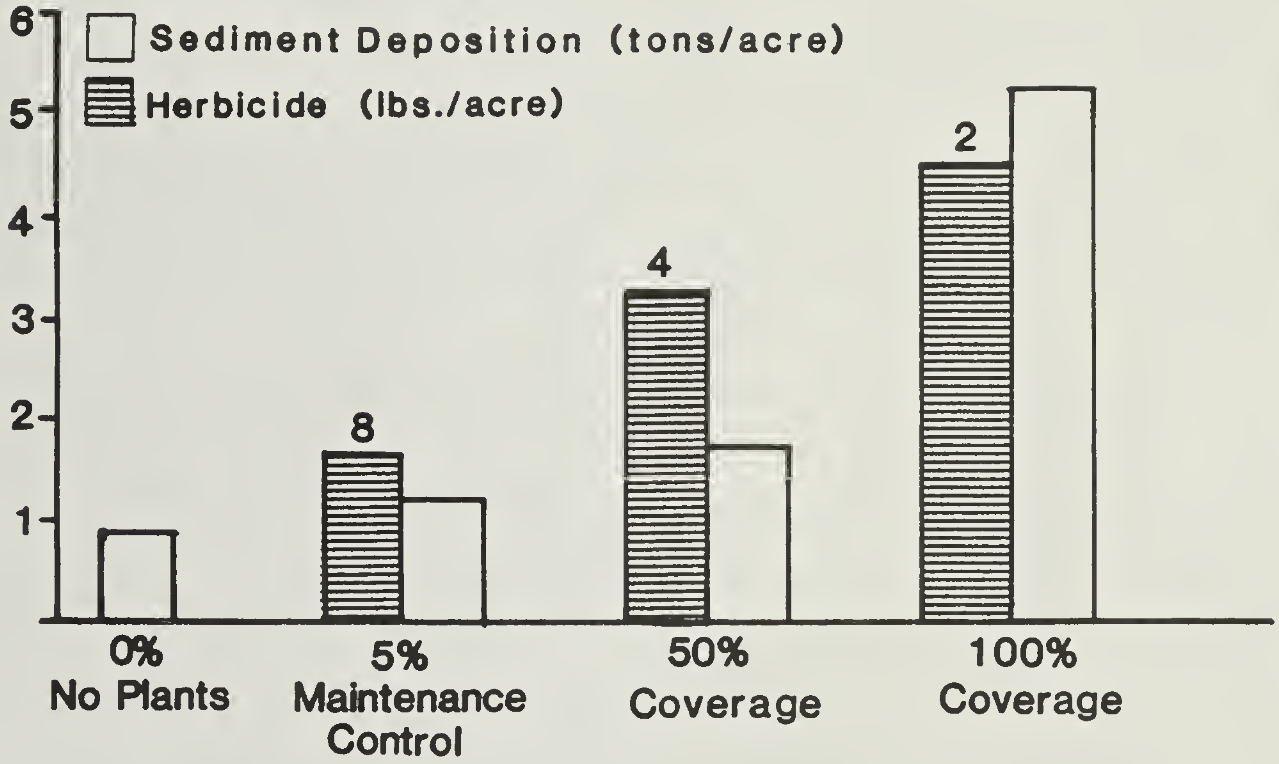
Florida State Statute, Chapter 372.925, defines maintenance control as "a method of managing exotic aquatic plants in which control techniques are utilized in a coordinated manner on a continuous basis in order to maintain a plant population at the lowest feasible level."

There is a great deal of debate as to what the "lowest feasible" levels of problem plants should be. However, it is generally agreed that the levels vary according to the plant species, location and management objectives of given water bodies.

Dr. Joe Joyce of the U.F. Center for Aquatic Weeds recently published results relevant to maintenance control practices. His research shows that maintenance control methods result in the use of less herbicides, the deposition of less organic matter (from dead leaves and plants) in the lake bottom, less overall environmental impact by weeds, and reduced management costs. See the bar graph below.

The shaded bars of the graph show pounds of herbicide used to control waterhyacinths on a one-acre pond per year at different vegetation levels. One of the purposes of maintenance control is to reduce the amount of herbicide used in water bodies. The graph shows that maintenance control requires the use of less herbicide, in this case 60% less per year. (The number over each bar indicates the number of site-visits per year.)

The un-shaded bars of the graph shows the annual organic sedimentation resulting from chemical control of waterhyacinths in a one-acre pond. Another purpose of maintenance control is to reduce the amount of sediments produced by the plants. The graph shows that maintenance control results in much less sediment deposition per year. These sediments reduce water depth, reduce oxygen levels, and cover fish spawning areas.



ABC NEWS AND AQUATIC PLANTS

Millions of television viewers learned something about using aquatic plants for wastewater purification last year in an ABC News segment. In a regular newscast, ABC interviewed Dr. B.C. Wolverton (NASA, Bay St. Louis, Mississippi, USA) about the ability of water hyacinth (*Eichhornia crassipes*) to remove heavy metals and other pollutants from industrial wastewater. Also shown to viewers was the new San Diego (California, USA) wastewater facility which uses acres of water hyacinths ponds for domestic wastewater treatment. San Diego is the eighth most populous city in the United States and the aquaculture part of the system is expected to treat 40% of the city's wastewater.

The research of Wolverton, R.C. McDonald, K.R. Reddy and other researchers since the early 1970s has shown that water hyacinths and other aquatic plants can remove pollutants from water systems. Several cities in Florida, Texas and California have used these systems, but San Diego's appears to be the largest anywhere. ABC reported that such systems cost about half what other types of wastewater treatment systems cost. Asked why other cities have not opted to use aquatic plant and wetland treatment systems, Wolverton replied that the systems are "just too simple".

The Aquatic Weed Program's database contains several hundred research articles and books about the abilities of many aquatic plants to accumulate water pollutants.

COMPETITION BETWEEN *HYGROPHILA* AND *HYDRILLA*

Hydrilla continues to be a major nuisance in irrigation and flood-control canals and other flowing waters. However, competition studies at the University of Florida Center for Aquatic Weeds have shown that another exotic plant (*Hygrophila polysperma*) may be able to outcompete hydrilla in especially fast-flowing waters. This could be more bad news for water managers in places where hygrophila has been introduced. For example, hygrophila has been introduced into South Florida irrigation and flood-control canals, and in some of the canals, hygrophila has successfully competed with hydrilla.

In the competition studies, researchers demonstrated that hygrophila produced a 3 to 5-fold increase in biomass in flowing water with turnover times of 1 to 5 hours. In contrast, hydrilla biomass increased 2-fold in water with turnover times of 2 and 5 hours. The researchers noted that treatment of canals with herbicides for the control of hydrilla "would favor the expansion of hygrophila which is more resistant to herbicides labelled for hydrilla control."

The research was conducted by Gerda van Dijk and Dan Thayer, under the direction of Dr. William Haller. Van Dijk was a visiting student from The Netherlands.

PEEM

Three international organizations have created and support a panel of experts to help countries control diseases such as schistosomiasis and malaria. The Panel of Experts on Environmental Management for Vector Control (PEEM) operates under the auspices of the World Health Organization (WHO), the Food and Agriculture Organization (FAO) and the United Nations Environment Program (UNEP).

The panel of about 30 experts was created five years ago. Its main goals are to increase awareness of the need to solve vector-borne disease problems by means of environmental management, to encourage the incorporation of health safeguards into environmental management and to study the effects of management methods on vectors of diseases. Because most of the target diseases are spread by water-borne vectors, most of PEEM's work has to do with the development and management of irrigation projects, rice production and flood control systems.

Among PEEM's new projects is the study of the effects of azolla use on the mosquito-vectors present in ricefields. Azolla is an aquatic plant which is used as a "biofertilizer" in ricefields. Information is needed on whether or not using azolla increases the risk of disease spread by providing breeding places for *Anopheles* and *Culex* mosquitoes.

The PEEM Newsletter is published four times a year, in English and French. Other PEEM publications include: 1) The global scale of health problems of water resources development. 2) Health problems in small scale water resources development projects. 3) Guidelines for forecasting vector-borne disease implications resulting from the development of water resources projects. PEEM can be contacted through Dr. Robert Bos, PEEM Secretariat, World Health Organization, 1211 Geneva 27, SWITZERLAND.

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Larva of *Hydrellia pakistanae* makes a meal of *Hydrilla* leaf.

Dr. Gary Buckingham, USDA Entomologist

HYDRELLIA ON HYDRILLA

A minute aquatic fly (*Hydrellia pakistanae*) from Pakistan and India has become a primary candidate for study of the biological control of the menace aquatic weed hydrilla (*Hydrilla verticillata*). "Extensively damaged" mats of hydrilla recently were observed in Pakistan and India by U.S. researchers Dr. Gary Buckingham and Ms. Christine Bennett and, earlier, by Dr. Joseph Balciunas. Larval stages of the fly mine hydrilla leaves and stems, heavily damaging the plants. Buckingham and Bennett have collected the flies for quarantine studies in the Division of Plant Industry quarantine facility in Gainesville, Florida. If their studies are successful and permission for release is received from various agencies, small-scale outdoor tests against hydrilla could be attempted by early 1987.

Hydrellia on hydrilla was first discovered in the 1970s by researchers of the Commonwealth Institute of Biological Control Rawalpindi (Pakistan) Station, working under a United States research grant (PL-480). The fly was "rediscovered" by Balciunas in southern India in his 1981 and '82 round-the-world trips to identify insects which attack hydrilla. In 1985, Buckingham and Bennet went to Pakistan and India to collect samples of *Hydrellia,* as well as to conduct other field work.

According to a CIBC-Pakistan report, a single *Hydrellia* larva can damage an average of 12 leaves before reaching maturity. The entire life cycle from egg to adult is 18-31 days and the fly lays a maximum of about 50 eggs in its lifetime. No studies about its biological control potential have been published.

Buckingham and Bennett have begun their work by raising populations of the flies in quarantined tanks of hydrilla. In various experiments, they hope to verify the fly's host-specificity to hydrilla in Florida. They also are studying the fly's short life-cycle and will devise culture techniques.

Buckingham has worked on biological control methods for more than 15 years. He is a United States Department of Agriculutre research entomologist (ARS). Bennett is an entomologist with the University of Florida (IFAS) Department of Entomology and Nematology. They are stationed at the USDA Biological Control Laboratory in Gainesville. Their address is: Biological Control Laboratory, P.O. Box 1269, Gainesville, Florida 32602.